Study Types
in Biomedical Research:
General Principles

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## Observational vs. Interventional studies:

<table>
<thead>
<tr>
<th>Freedom to select the samples for study</th>
<th>Freedom to expose the samples to specific amounts of specific exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

- **Interventional Studies**
  - Freedom to select the samples: Yes
  - Freedom to expose the samples: Yes

- **Quasiexperimental Studies**
  - Freedom to select the samples: No
  - Freedom to expose the samples: Yes

- **Observational Studies**
  - Freedom to select the samples: No
  - Freedom to expose the samples: No
A. **Interventional**: study factor is manipulated by the investigator

B. **Observational**: no manipulation of study factor by the investigator
**Examples:**

<table>
<thead>
<tr>
<th>Observation:</th>
<th>Experiment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• a survey of smoking habits among students;</td>
<td>• encouraging bikers in one group to stop smoking cigarettes to see whether they get less belligerent;</td>
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<tr>
<td>• a researcher who joins a tribe to study their lifestyle;</td>
<td>• warning one group of students that you are going to take blood alcohol levels next Monday to test for alcohol, and comparing their levels to another group that you did not warn.</td>
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<tr>
<td>• taking blood samples to measure blood alcohol levels during Monday morning lectures (yes, you are intervening to take the blood, but you are not trying to change the blood alcohol level: it's just a measurement).</td>
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Observational studies

Descriptive S.
seeks to measure the frequency in which diseases occur or collect descriptive data on possible causal factors.

Analytical S.
_attempts to specify in more detail the causes of a particular disease.
Observational Studies

- Case Reports
- Case Series
- Cross Section
- Case-Control
- Cohort
Objective: To make observations about patients with defined clinical characteristics (e.g., patients with a certain disease or cluster of symptoms)
Design: Simple description of clinical data without comparison groups, the data derived from a well-defined group of individuals

- **Case Report**: One case of unusual injury finding
- **Case Series**: Multiple cases of injury finding
Example:

- You have a patient that has a condition that you are unfamiliar with. You would search for case reports that could help you decide on a direction of treatment or to assist on a diagnosis.

- A researcher identifies a group of patients who were incorrectly diagnosed with Lyme Disease, then records whether the patients experienced adverse effects from the antibiotics they were prescribed for treatment of Lyme.
CASE-CONTROL STUDIES
Sample
  Case
    Risk Factor +
    Risk Factor -
  Control
    Risk Factor +
    Risk Factor -
Odd’s Ratio = \frac{a \times d}{c \times b} (Relative Odd’s)
Case-Control Notes:

- Recall Bias
- Matching
- Cheaper than Cohort
- Less accurate than Cohort
- More Suitable for rare diseases
you could identify a group of patients with brain cancer. Then identify a control group who do not have brain cancer. Then, collect information on their previous use of cell phones, dating back as far as you can manage.(phone bills) The hypothesis would be that phone usage would be significantly higher in the cancer group than the control group;
Examples:

- A study in which colon cancer patients are asked what kinds of food they have eaten in the past and the answers are compared with a selected control group.

- A researcher identifies a group of individuals with AIDS who have low medication compliance. The researcher administers a questionnaire to the patients to determine what factors relate to their poor compliance.
COHORT STUDIES
Sample

Exposed

Disease+

Disease -

Unexposed

Disease+

Disease -

Risk = a/(a+b)

Risk = c/(c+d)

Relative Risk (Risk Ratio) = (a/(a+b))/(c/(c+d))
Interpreting Relative Risk (RR) of a Disease

If \( RR = 1 \)
- Risk in exposed equal to risk in unexposed (no association)

If \( RR > 1 \)
- Risk in exposed greater than risk in unexposed (positive association; possibly causal)

If \( RR < 1 \)
- Risk in exposed less than risk in unexposed (negative association; possibly protective)
Prospective Cohort

- **Prospective**: 2008
- **Defined Population**
- **Non-Randomized**
  - **Exposed**
    - 2028: Disease
    - 2028: No Disease
  - **Non-Exposed**
    - 2028: Disease
    - 2028: No Disease
Retrospective Cohort

Defined Population

NON-RANDOMIZED

Exposed

Non-Exposed

Disease
No Disease
Disease
No Disease

Retrospective
1988
1998
2008
Comparison
Notes in Cohort Design

- Follow up
- More Expensive
- More accurate than Case – Control Studies
- Long time
- Suitable for common disease
- Biases
Example:

- Maybe you want to see whether using a cell phone leads to brain cancer. So, collect information on how many minutes each student uses their phone each week (phone bills), and collect this information over a long time, and then eventually collect information on who gets brain cancer. You could then see whether the cases of brain cancer arose among the people who used their cell phones most often. In technical terms, you record the incidence of cancer among those who use their phones more than a pre-determined amount and compare this to the incidence in the non-users.
Example:

• A researcher identifies a group of elderly immobilized patients in a nursing home. The researcher follows the patients for 6 months and records the administration of any topical (skin) agent. At the end of the study period, the researcher conducts an analysis to determine whether certain topical regimens related to reduced incidence of bed sores.
CROSS-SECTIONAL
STUDIES
Cross-sectional Design

- Sample a group of subjects.
- Observe disease and risk factor status.
- Test for relationship.

Disadvantages

- Weakest observational design, (it measures prevalence, not incidence of disease). Prevalent cases are survivors
- The temporal sequence of exposure and effect may be difficult or impossible to determine
- Usually don’t know when disease occurred
Example:

• what is the prevalence of diabetes in this community? Here, you draw a random sample of people and record information about their health in a systematic manner. You can also compare people with, and without, diabetes in terms of characteristics (such as being overweight) that may be associated with the disease. The problem is that you cannot be sure which came first: the diabetes or the weight problem, so this is a very weak design for drawing conclusions about causes.
Descriptive vs. Analytic Studies

Observational Studies
- Case Report
- Case Series
- Cross Section
- Case-Control
- Cohort

Descriptive Studies

Analytic Studies
Interventional Studies

CLINICAL TRIALS
Experimental study (Clinical Trials)

**THE PRESENT**

- Population
  - Sample
  - Treatment
  - Placebo

**THE FUTURE**

- Disease - No disease
  - Disease - No disease

**Steps:**
1. Select a sample from the population
2. Measure baseline variables
3. Randomize
4. Apply interventions (one should be a blinded placebo, if possible)
5. Follow-up the cohort
6. Measure outcome variables (blindly, if possible)
Study begins here (baseline point)

Study population

Intervention

Control

outcome

no outcome

outcome

no outcome

RANDOMIZATION

time

baseline

future

Study begins here (baseline point)
Note: Randomization is a design model, it differs from Random Sampling.
Clinical Trials

- Groups are alike in all important aspects and only differ in the intervention each group receives
- Randomization
- Placebo
- Blindness
Examples:

• A researcher assembles two groups of study participants with Lyme Disease. She administers the antibiotic doxycycline to one group and amoxicillin to the other. The researcher then measures which has more of a beneficial effect.

• A researcher identifies two groups of elderly immobilized patients in a nursing home. One group of patients is repositioned every two hours. The other group is repositioned every 1.5 hours. The researcher measures whether the incidence of bedsores is lower in the group repositioned every 1.5 hours than the group repositioned every 2 hours.
CHARACTERISTICS OF STUDIES

**Timing**
- Retrospective
- Prospective
- Concurrent

**Direction**
- Forward
- Backward
Prospective Study

looks forward, looks to the future, examines future events, follows a condition, concern or disease into the future.
Retrospective Study

“to look back”, looks back in time to study events that have already occurred
Direction

- Forward
- Backward
- Non-directional

Forward: E → D
Backward: D → E
Thanks for your attention

ANY QUESTION?